City of Raleigh and NC State Smart Cities Partnership Project Ideas Whitepaper

PI: Warren Jasper, PhD, PE
Tel: (919) 515-6565
Email: wjasper@ncsu.edu

Project Title:

An IOT Climate Control System for Office Buildings

Smart City Collaborative Overview:

The City of Raleigh and North Carolina State University wish to collaborate on project opportunities to leverage software, sensors and network technology to improve the City's strategic vision and operations. The collaboration will focus on opportunities that leverage NC State's strengths in skill and position as a trusted third party within the Triangle area, the University's dedication to research that improves the lives of everyday North Carolinians, and its statewide network of university professors and specialist resources.

Problem Description:

According to the US Department of Energy, about 15% of all the energy consumed in the United States is for the air conditioning of residential and commercial office buildings. With global climate change, this number is expected to rise. US DOE estimates that if the average temperature were increased by 3 degrees Fahrenheit in the summer and decreased just 3 degrees in the winter, up to 10% savings in overall energy consumption could be realized. In addition, many buildings, or large areas of buildings are heated and cooled while un-occupied, resulting in wasted energy and money. The problem is that retrofitting sensors to building HVAC systems has been prohibitively expensive, and municipalities have not been able to justify the cost thus making this study more of an operational business challenge.

Vision or Desired Outcome(s):

We propose an inexpensive, intelligent and secure climate control system that uses a small inexpensive computer, such as a Raspberry Pi, and a USB temperature sensor to control the temperature of a room (especially auditoriums and conference rooms) by linking via the internet the central HVAC system operation to a software calendar such as Google calendar. Thus, by knowing when a room will be occupied and by how many people, a more efficient allocation of conditioned air can be made. At current prices, an internet aware smart thermostats are very affordable making this technology easier to implement. The air conditioning system can be switched on an hour or so before a scheduled event. The time before which the air conditioning system will be on can be calculated based on the ambient temperature, humidity, and projected occupancy. The proposed system will have the flexibility to either pull the schedule from a calendar or control it online using an app. Most auditoriums and conference rooms have Wi-Fi capabilities, which will allow the computer to send the temperature in the room along with the desired room temperature from the software calendar to the A/C unit to achieve a closed loop

control. We anticipate reduction in energy costs by least one quarter with detailed cost studies provided as a result of this project.

Anticipated Timeline / Duration:

1. The first step is to perform a feasibility study to understand the operation of the current system and the amount of savings that are possible.
2. Perform a cost estimation of the proposed system to understand the costs associated with the project.
3. Communicate with different stakeholders (City of Raleigh operations and maintenance personnel, a/c system OEM, BMS) to discuss/understand everyone's scope.
4. Provide the algorithms to the City of Raleigh programming team/operations team to incorporate in the BMS/a/c controls.
5. Develop cyber security analysis/audit to insure hard encryption at all phases of the project.

Project Description:

	NC State would provide:	**Raleigh would provide:**
Project Lead	Dr. Warren Jasper	
Role of Participants	Lead needs analysis of heat load and optimization of temperature control. Design and implement wireless IOT temperature controller.	Operations/Maintenance engineers, Programmers
Key Activities	Feasibility studies, technical know-how, algorithms.	Programming, incorporate it in the building HVAC controls.
Data Needed	Current operational data and knowledge of air-conditioning systems and controls	Operations engineers will provide us the data and help with the integration. Programmers will help with integrating the algorithms with chilling plant operation
Time Required	Students: 1 year Faculty Time: 1 month	

Third Party Partners Required:

This project requires making modifications in the control system the central air-conditioning systems and hence will require working with controls companies such as Schneider Electric or Johnson's Controls.